ATTACHMENT C

SUPPLEMENTAL INFORMATION PERTAINING TO PARAMETER/CONSTITUENT LOADING TABLES

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Bromide Loading Notes

Note a. Agricultural Drains

Lower Sacramento Basin - Bromide loads from agricultural drains were estimated based on water quality data reported in CUWA (1995) combined with flow data reported in CVRWQCB (1988). Bromide concentrations were reported at the Natomas East Main Drain that consisted of 44 samples obtained over the period of 10/1/89 through 8/29/93. The mean bromide concentration was about 0.1 mg/l and the standard deviation was 0.035. The mean value was assumed to be representative of major drains in the Sacramento Basin, specifically Sacramento Slough, Colusa Basin Drain, RD 108, RD 1000, and Toe Drain for which flow data for 1985 are provided in Table V-3 (CVRWQCB, 1988). The total flow-rate from these drains in 1985 was reported to be about 1.4x10^6 acre ft.

The equation used to estimate mean annual load was:

Load (lbs/yr) = 2.71 x Q (acre-ft/yr.) x conc. (mg/l)

where the factor 2.71 is for units conversion.

Using the mean concentration of 0.1 mg/l and the annual flow-rate of 1.4x10^6 acre-ft/yr. in this equation yields about 380,000 lbs/yr which is the value reported in Table 3.6.

Note e. Basin Emissions

The sources of data for estimating basin emissions varied depending on the constituent, but included: the Study of Drinking Water Quality in Delta Tributaries (CUWA, 1995), water quality data collected as part of DWR's Municipal Water Quality Investigations Program, USGS water quality data (EarthInfo, 1996), water quality data reported by the Interagency Ecological Program (IEP), and special studies of water quality such as the "Water Quality Data, San Joaquin Valley, California, April 1987 to September, 1988 (Shelton and Miller, 1991). Flow data sources included USGS flow data as reported in its annual Water Resources Data Reports, and DWR's DAYFLOW database.

Lower Sacramento Basin - Figure I-2 (CUWA, 1995) shows bromide concentrations measured at Greene's Landing on the Sacramento River for the period of 1/9/90 through 3/11/94. Of 64 samples obtained during that period, 31 are reported as 0.02 mg/l and 19 are reported as 0.01 mg/l. Thus 50 samples (about 80%) of the total number of samples appear to be values assigned to non-detects. At locations such as Greene's Landing where the flows are high and there are numerous non-detects, the estimation of loads is very uncertain. The approach taken in this situation was to assume that most sample concentrations were likely less than 0.01 mg/l and to use this value to estimate an upper bound load.

The equation used to estimate mean annual load was:

Load (lbs/yr) = 2.71 x Q (acre-ft/yr.) x conc. (mg/l)

where the factor 2.71 is for units conversion.

Use of this equation with a concentration of 0.01 mg/l and a runoff flow of 16.6 x 10^6 acre-ft/yr. (mean annual runoff at Freeport for 1949-94) yields an upper bound load of 450,000 lbs/yr, which was entered in Table 3.6.

San Joaquin Basin - Data reported in Figure I-4 (CUWA, 1995) for the period 1/1/90 through 9/27/93 shows 47 samples with a mean of about 0.4 mg/l and an standard deviation of about 0.13 mg/l. Using the mean concentration of 0.4 and a mean annual flow-rate at Vernalis of 1.22 x 10^6 acre-ft/yr (water year 1994) in the above equation yields a load of 1.3 x 10^6 lbs/yr which is entered in Table 3.6. It should be noted that a primary source of bromide to the Delta is seawater intrusion from San Francisco Bay, and much of the bromide at Vernalis is bromide from this source which is recirculated via the pumping facilities, aqueducts and drains back into the lower San Joaquin River.

Cadmium Loading Notes

Note a. Agricultural

Estimates of the contribution of cadmium from agricultural sources were obtained from A Mass Loading Assessment of Major Point and Non-Point Sources Discharging to Surface Waters in the Central Valley, California, 1985, by Montoya, Blatt, and Harris, (CVRWQCB, 1988), and the final version of the report published in March 1989 (CVRWQCB, 1989).

Lower Sacramento Valley- Table V-8 of the 1988 report (CVRWQCB, 1988) presents annual cadmium loads from Sacramento Valley agricultural drains. Loads were calculated from the following five major agricultural drains: Sacramento Slough, Colusa Basin Drain, RD1000, RD108, and Toe Drain. The loads were estimated using 1985 flow volumes and 1985-1987 concentration data. Flow volumes were obtained from USGS and DWR data banks, reclamation district records and DWR DAYFLOW reports. Concentration data were obtained from the Central Valley Regional Board and SWRCB. Concentrations reported as non-detects were assigned zero values for the loads calculations. Loads were calculated separately for the rice season (May through June) and non-rice season because most pesticides are applied during the rice season.

The annual cadmium load from the five agricultural drains was estimated to be 546 pounds, as indicated in Table V-8 of the 1988 report (CVRWQCB, 1988). However, the final 1989 report (CVRWQCB 1989) indicated that the 1988 report load estimates were biased low due to the omission of some important agricultural sources. The adjusted annual cadmium load from agricultural sources is provided in Table 1 of the 1989 report (CVRWQCB 1989), and is estimated to be 600 pounds. The load of 600 pounds is the value entered in Table 3.7 of this report.

It should be noted that the adjusted loads accounted for sources above the dams in addition to those below the dams. In Table 1, agricultural sources above the dams are considered to be minimal. It is known that pesticide and herbicide application practices have changed since the load estimates were performed in 1988; however more recent agricultural drainage water quality data for metals do not appear to be available.

Note b. Mining

Estimates of the contribution of cadmium from mining sources were based primarily on data summarized from the following documents: A Mass Loading Assessment of Major Point and Non-Point Sources Discharging to Surface Waters in the Central Valley, California, 1985 (CVRWQCB, 1988); the final version of this report which was published in March 1989 (CVRWQCB, 1989), and Inactive Mine Drainage in the Sacramento Valley, California, by Montoya and Pan in 1992 (CVRWQCB, 1992).

Delta - Inactive mines located in and near the Delta include Penn Mine, Newton Mine, and Mt. Diablo Mine. According to Table IV-3 (CVRWQCB, 1988), these mines are not considered major sources of cadmium.

San Joaquin Basin - Inactive mines in the San Joaquin Basin include the New Idria Mine, for which flow and cadmium data for 5 sampling rounds during 1971-1977 are presented in Table IV-7 (CVRWQCB, 1988). Based on these data, a mean annual load estimate of about 10 lbs/yr was made.

Upper Sacramento Valley - Inactive mines in the Upper Sacramento Basin (above the major dams) include Little Backbone Creek and Shoemaker Gulch, West Squaw Creek, Rising Star, and Bully Hill. Based on loading estimates for these mines in Table V-1 (CVRWQCB, 1992), the mean annual load from these mines in the drought period of 1987-1991 was 535 lbs/yr.

Lower Sacramento Valley - According to (CVRWQCB, 1992), there are at least 16 inactive mines in the Sacramento Valley below the major dams, the most prominent of which is Iron Mountain. Table V-1 (CVRWQCB, 1992) provides loading estimates for these mines for the drought period of 1987-1991. Based on this table the mean annual load for cadmium from these

16 mines was estimated at about 3400 lbs/yr. In 1985, the annual cadmium load from Iron Mountain Mine (which may account for more than 95% of the total load for all mines) was estimated to be 4800 lbs/yr (CVRWQCB, 1992, Table IV-9).

Sacramento Valley - The total load for the Sacramento Valley was estimated to be 19,200 lbs/yr (CVRWQCB, 1989, Table 1), and this was apportioned between the upper and lower portions of the Valley based on the 1987-1991 data cited above. Using these data the portion of the 19,200 lbs/yr attributed to the Upper Sacramento Valley was 535/(535+3400) or about 14%, which is about 2600 lbs/yr. The remaining 16,600 lbs/yr was attributed to the Lower Sacramento Valley.

Note c. Municipal and Industrial Wastewater

Municipal and industrial wastewater load estimates for cadmium are difficult to quantify as some of the data are below detection limits (typically when detection limits of 1-2 ug/l are employed); therefore estimates can differ widely depending on how the non-detect data are interpreted. This is especially a problem where effluent flows are high. The primary sources for these estimates were CVRWQCB, 1988, CVRWQCB, 1992, State of Estuary Report (SFEP, 1992), and discharge reports submitted by individual WWTPs in compliance with NPDES permits. The primary sources considered were municipal rather than industrial sources, except where a compilation of industrial sources was already available.

Delta Region - The larger WWTPs in the Delta are those operated by the cities of Stockton, Manteca and Tracy, with Stockton being by far the larger discharge. Mean monthly flow discharges for the year 1985 at Stockton were about 25 MGD, compared to about 5 MGD for Tracy (CVRWQCB, 1988). The 1985 loads from Stockton and Tracy were 60 lbs/yr and 17 lbs/yr respectively, and the sum of these estimates (rounded to 80 lbs/yr) was used in Table 3.7.

Lower Sacramento Basin - WWTPs in the lower Sacramento Valley include the Sacramento Regional and Redding Plants. Estimates for Sacramento and other NPDES charges for 1985 were about 100 lbs/yr (CVRWQCB, 1989) and this value is used in Table 3.7.

San Joaquin Valley - WWTPs in the San Joaquin Valley include Fresno and Modesto. The City of Modesto provided monitoring data for NPDES requirements, but these did not include metals data. Further research is required.

Bay Region - Cadmium loading estimates in the State of the Estuary Report in Table 19 range from 1.8-4.0 metric tons/yr for major municipal and industrial sources (SFEP, 1992).
An intermediate value of 3 metric tons/yr was then converted to approximately 6600 lbs/yr (there are 2205 lbs/metric ton).

Upper Sacramento Basin - M & I sources of cadmium, which are minimal in the Upper Sacramento, are considered insignificant.

Note d. Urban Runoff

Delta - Urban runoff estimates were obtained from A Mass Loading Assessment Report published by the Central Valley RWQCB (CVRWQCB, 1988, Tables VI-4, VI-5). Load estimates were made for the following seven cities in and near the Delta: Stockton, Vacaville, Lodi, Woodland, Manteca, Tracy, and Davis based on annual rainfall, urban acreage, and a runoff factor of 0.3. Water quality data for the City of Sacramento was used for all areas. Total annual metals loads for the Central Valley given in Table VI-4 were apportioned to the Delta, Sacramento Valley, and San Joaquin Valley using total urbanized area as given in Table VI-5. Given that these estimates did not include all urbanized areas and do not include increased urbanization since 1985, a correction factor of 1.3 was arbitrarily assigned to the loads. Using this approach for cadmium, the result was 700 lbs (from Table VI-4) x 0.15 (from Table VI-5) x 1.3 = 137 lbs, which was rounded up to 150 in Table 3.7.

Lower Sacramento - Load estimates for the Lower Sacramento were reported in the loads assessment conducted by the Central Valley Regional Board (CVRWQCB, 1988) based on information for the following cities: Sacramento, Redding, Chico, Roseville, Paradise, and Yuba City. Using the same method described for the Delta, the mean annual cadmium load was calculated at 700 lbs (from Table VI-4) x 0.64 (from Table VI-5) x 1.3 = 582 lbs, which was rounded up to 600 lbs in Table 3.7.

San Joaquin - Load estimates for the San Joaquin Basin were reported in the loads assessment conducted by the Central Valley Regional Board (CVRWQCB, 1988) based on information for the following cities: Madera, Modesto, Merced, Turlock, Ceres, and Atwater. Using the same method as described for the Delta, the mean annual cadmium load was calculated to be 700 lbs (from Table VI-4) x 0.21 (from Table VI-5) x 1.3 = 191 lbs, which was rounded up to 200 lbs in Table 3.7.

Bay Region - Cadmium load estimates for the Bay Region were obtained from the State of the Estuary Report (Table 19) which gives a range of 0.3-3.0 metric tons/yr. Using an intermediate value of about 1.5 metric tons/yr, this converts to about 3300 lbs/yr. A rounded value of 3000 lbs/yr was entered in Table 3.7.

Note e. Basin Estimates

San Joaquin River Basin - Cadmium data for the San Joaquin River at Vernalis were obtained from the USGS Water Resources of California data site for the years 1985-1990. A total of 65 samples were reported for this 5 year period, but most of the data were below detection limits, where the detection limits were commonly 0.1 ug/l or 0.05 ug/l. In situations where most data are below detection limits, load estimates are highly uncertain, and the best one can do is estimate an upper bound. In this case, we assumed that most concentrations were likely to be less than 0.05 ug/l and, using the equation:

Load (lbs/yr) = 2.71 x Q (acre-ft/yr) x c (mg/l)

with Q equal to about 1.22 x 10^6 acre-ft/yr (WY 1994), the upper bound load was calculated to be 163 lbs. This was rounded and entered as 160 lbs in Table 3.7.

Copper Loading Notes

Note a. Agricultural

Estimates of the contribution of copper from agricultural sources were obtained from A Mass Loading Assessment of Major Point and Non-Point Sources Discharging to Surface Waters in the Central Valley, California, 1985, by Montoya, Blatt, and Harris, (CVRWQCB, 1988), and the final version of the report published in March 1989 (CVRWQCB, 1989).

Lower Sacramento Valley- Table V-8 of the 1988 report (CVRWQCB, 1988) presents annual copper loads from Sacramento Valley agricultural drains. Loads were calculated from the following five major agricultural drains: Sacramento Slough, Colusa Basin Drain, RD1000, RD108, and Toe Drain. The loads were estimated using 1985 flow volumes and 1985-1987 concentration data. Flow volumes were obtained from USGS and DWR data banks, Reclamation District records and DWR DAYFLOW reports. Concentration data were obtained from the Central Valley Regional Board and SWRCB. Concentrations reported as non-detects were assigned zero values for the loads calculations. Loads were calculated separately for the rice season (May through June) and non-rice season because most pesticides are applied during the rice season.

The annual copper load from the five agricultural drains was estimated to be 35,000 pounds, as indicated in Table V-8 of the 1988 report (CVRWQCB, 1988). However, the final 1989 report (CVRWQCB 1989) indicated that the 1988 report load estimates were biased low due to the omission of some important agricultural sources. The adjusted annual copper load from agricultural sources is provided in Table 1 of the 1989 report (CVRWQCB 1989), and is estimated to be 41,000 pounds. The load of 41,000 pounds is the value entered in Table 3.8 of this report.

It should be noted that the adjusted loads accounted for sources above the dams in addition to those below the dams. In Table 1, agricultural sources above the dams are considered to be minimal. Pesticide and herbicide application practices are known to have changed since the load estimates were performed in 1988; however more recent agricultural drainage water quality data for metals do not appear to be available.

Note b. Mining

Estimates of the contribution of copper from mining sources were based primarily on data summarized from the following documents: A Mass Loading Assessment of Major Point and Non-Point Sources Discharging to Surface Waters in the Central Valley, California, 1985, by Montoya, Blatt, and Harris, (CVRWQCB, 1988), the final version of this report published in March 1989 (CVRWQCB, 1989), and Inactive Mine Drainage in the Sacramento Valley, California, by Montoya and Pan, RWQCB, Central Valley Region, July 1992 (CVRWQCB, 1992)

Delta - Inactive mines located in and near the Delta include Penn Mine, Newton Mine, and Mt. Diablo Mine. Table IV-6 (CVRWQCB, 1988), provides an estimate of the mean daily copper load from Newton Mine at 11.4 lbs/day, which was multiplied by 365 to yield an annual estimate of about 4100 lbs/yr. Given that data from other mines were not reported, the load from Newton Mine alone was used as the basis for the rounded value of 4000 lbs/yr given in Table 3.8.

San Joaquin Basin - Inactive mines in the San Joaquin Basin include New Idria Mine, for which a daily load of 0.6 lbs/day was estimated based on flow and copper data for 5 sampling rounds during 1971-1977 (CVRWQCB, 1988, Table IV-7). Based on the daily value, a mean annual load estimate of about 220 lbs/yr was made.

Upper Sacramento Valley - Inactive mines in the Upper Sacramento Basin (above the major dams) include Little Backbone Creek and Shoemaker Gulch, West Squaw Creek, Rising Star, and Bully Hill. Based on loading estimates for these mines given in Table V-1 of CVRWQCB (1992), the mean annual load from these mines in the drought period 1987-1991 was calculated to be about 58,000 lbs/yr.

Lower Sacramento Valley - Of the 16 largest inactive mines in the Sacramento Valley below the major dams, the most prominent is Iron Mountain Mine. Table V-1 of CVRWQCB (1992) provides loading estimates for these mines for the drought period 1987-1991. Based on this table, the mean annual load for copper from these 16 mines is about 83,000 lbs/yr. In 1985, the annual copper load from Iron Mountain Mine (which may account for more than 95% of the total load from all of these mines) was estimated to be approximately 137,000 lbs/yr (CVRWQCB, 1988, Table IV-9).

Sacramento Valley - The total copper load for the Sacramento Valley was estimated to be 548,000 lbs/yr (CVRWQCB, 1989, Table 1). This estimate takes into account mining sources (above and below major dams) that were not included in the original estimates, and thus reflects most major mining sources in the Sacramento Valley. This load was apportioned between the upper and lower portions of the Valley based on the 1987-1991 data. Using these data, the proportion of the 548,000 lbs/yr attributed to the Upper Sacramento Valley was 58/(58+83) or about 40%, which is about 220,000 lbs/yr. The remaining 328,000 lbs/yr was attributed to the Lower Sacramento Valley.

Note c. Municipal and Industrial Wastewater

Municipal and industrial wastewater load estimates for copper were obtained from estimates given in CVRWQCB, 1988, CVRWQCB, 1992, State of Estuary Report (SFEP, 1992), and discharge reports submitted by individual WWTPs in compliance with NPDES permit requirements. The primary sources considered were municipal rather than industrial sources, except where a compilation of industrial sources were already available.

Delta Region - The larger WWTPs in the Delta are those operated by the cities of Stockton, Manteca and Tracy, with Stockton being by far the larger discharge. Mean monthly discharge flows for the year 1985 from Stockton were about 25 MGD, compared to about 5 MGD for Tracy (CVRWQCB, 1988). The 1985 copper load from Stockton was estimated at 1572 lbs and copper samples at Tracy were below detection. A rounded estimate of 2000 lbs/yr was used in Table 3.8.

Lower Sacramento Basin - WWTPs in the lower Sacramento Valley include Sacramento Regional and Redding. Estimates for Sacramento WWTP and other NPDES dischargers for 1985 totaled about 6000 lbs/yr (CVRWQCB, 1989) and this value was used in Table 3.8.

San Joaquin Valley - WWTPs in the San Joaquin Valley include Fresno and Modesto. The City of Modesto provided monitoring data for NPDES requirements, but these did not include metals data. The entry for Table 3.8 was therefore given as "further literature review required".

Bay Region - Copper loading estimates derived from Table 19 of the State of the Estuary Report ranged from 19-30 metric tons/yr for major municipal and industrial sources (SFEP, 1992). An intermediate value of 25 metric tons/yr was used which, converted to lbs/yr (there are 2205 lbs/metric ton), totals about 55,000. This value was entered in Table 3.8.

Upper Sacramento Basin - M & I sources of copper are minimal in the Upper Sacramento Basin and are considered insignificant.

Note d. Urban Runoff

Delta - Urban runoff estimates were obtained from A Mass Loading Assessment Report published by the Central Valley RWQCB (CVRWQCB, 1988, Tables VI-4, VI-5). Load estimates were made for the following seven cities in and near the Delta: Stockton, Vacaville, Lodi, Woodland, Manteca, Tracy, and Davis based on annual rainfall, urban acreage, and using a runoff factor of 0.3. Water quality data for the City of Sacramento was used for all areas. Total annual metals loads for the Central Valley given in CVRWQCB (1988) Table VI-4 were apportioned to the Delta, Sacramento Valley, and San Joaquin Valley using total urbanized areas as given in CVRWQCB (1988) Table VI-5. Given that these estimates did not include all urbanized areas and do not consider increased urbanization since 1985, a correction factor of 1.3 was arbitrarily assigned to the loads. For Copper this approach yields a result of 26,000 lbs (from Table VI-4) x 0.15 (from Table VI-5) x 1.3 = 5,070 lbs, which was rounded off to 5,000 lbs/yr for entry in Table 3.8.

Lower Sacramento - Load estimates for the Lower Sacramento were reported in the load assessment conducted by the Central Valley Regional Board (CVRWQCB, 1988) based on information for the following cities: Sacramento, Redding, Chico, Roseville, Paradise, and Yuba City. Using the same method as described for the Delta, the mean annual copper load was calculated as 26,000 lbs (from Table VI-4) x 0.64 (from Table VI-5) x 1.3 = 21,362 lbs, which was rounded off to 21,000 lbs/yr for Table 3.8.

San Joaquin - Load estimates for the San Joaquin Basin were reported in the load assessment conducted by the Central Valley Regional Board (CVRWQCB, 1988) based on information for the following cities: Madera, Modesto, Merced, Turlock, Ceres, and Atwater. Using the same method as described for the Delta, the mean annual copper load was calculated as 26,000 lbs (from Table VI-4) x 0.21 (from Table VI-5) x 1.3 = 7,098 lbs/yr, which was rounded off to 7000 lbs for Table 3.8.

Bay Region - Copper load estimates for the Bay Region were obtained from the State of the Estuary Report (Table 19) which gives a range of 7-59 metric tons/yr. Using an intermediate value of about 30 metric tons/yr, this converts to about 66,000 lbs/yr. A rounded value of 70,000 lbs/yr was entered in Table 3.8.

Note e. Basin Estimate Notes

San Joaquin Basin - Flow data for estimating basin emission loads were retrieved from the USGS Water Resources of California internet site http://water.wr.usgs.gov/ for the San Joaquin River near Vernalis (station #11303500), and constituent concentration data were obtained for the period 1985-1990 from EarthInfo/USGS Quality of Water database on CD-ROM (EarthInfo, 1996). During this period, a total of 117 water quality samples were taken.

In order to take into account possible seasonal changes in water quality, the load analysis was done by month. For example, all of the water quality samples for January from 1985 to 1990 were grouped together for the January mean load estimation. Any constituent concentration value that was below the detection limit was assumed to be half of the detection limit.
For each month of the year, days in which both water quality and flow were measured were identified and individual daily loads were calculated as the product of flow and concentration. Monthly mean loads were estimated based on the average of the daily loads for each month times the number of days in the month.

In order to account for the possibility that flows during the 5 year water quality record were not representative, monthly loads were corrected for flow by dividing by the following correction factor:

Fraction of Mean Monthly Flow = average flow for each month / long-term monthly mean flow. The long-term monthly mean flow was for the period 1924-1994 as provided in Volume 3 of the USGS Water Resources Data for Water Year 1994.

Note that the application of such a factor assumes that flow and water quality are not correlated, which is generally the case for the constituents considered (it is not the case for constituents such as TDS, TSS, and bromide.)

After taking into account the correction factors, the final monthly mean load equation is:

Monthly Mean Load = Average Daily Loads for the Month * Days of the Month / Fraction of Mean Monthly Flow.

The annual basin emission was the sum of the twelve monthly mean loads.

Using this methodology, the total annual copper load from the basin was estimated to be 91,000 lbs/yr and this value was entered in Table 3.8. For comparison, the annual load from the San Joaquin River into San Francisco Bay is estimated at 80 metric tons/yr (Table 19, SFEP, 1992) or about 175,000 lbs/yr.

Lower Sacramento Basin - For estimating basin emission loads, flow data were retrieved from the USGS Water Resources of California internet site http://water.wr.usgs.gov/ for the Sacramento River at Greene's Landing, and constituent concentration data were obtained for the period 1986-1990 from EarthInfo/USGS Quality of Water database on CD-ROM (EarthInfo, 1996). During this period, a total of 59 water quality samples were taken.

In order to take into account possible seasonal changes in water quality, the load analyses was done by month. For example, all of the water quality samples for January from 1986 to 1990 were grouped together for the January mean load estimation. Any constituent concentration value that was below the detection limit was assumed to be half of the detection limit.
For each month of the year, days in which both water quality and flow were measured were identified and individual daily loads were calculated as the product of flow times concentration. Monthly mean loads were estimated based on the average of the daily loads for each month times the number of days in the month.

In order to account the possibility that flows during the 5 year water quality record were not representative, monthly loads were corrected for flow by dividing by the following correction factor:

Fraction of Mean Monthly Flow = average flow for each month / long-term monthly mean flow.

Note that the application of such a factor assumes that flow and water quality are not correlated, which is generally the case for the constituents considered (it is not the case for constituents such as TDS, TSS, and bromide).

After taking into account the correction factors, the final monthly mean load equation is:

Monthly Mean Load = Average Daily Loads for the Month * Days of the Month / Fraction of Mean Monthly Flow.

The annual basin emission was the sum of the twelve monthly mean loads.

Using this methodology, the annual copper load from the basin was estimated at 700,000 lbs/yr and this value was entered in Table 3.8.

Mercury Loading Notes

Note b. Mining

There appear to be limited data available on mercury loading from inactive mines. One source of mercury information is "A Mass Loading Assessment of Major Point and Non-Point Sources Discharging to Surface Water in the Central Valley, 1985" by Montoya, Blatt, and Harris, (CVRWQCB, 1988). Table IV-6 of this reference shows 5 rounds of sampling conducted at the New Idria Mine in the San Joaquin Valley that were used to estimate a daily mercury load of 0.006 lbs/day. Assuming these data are reasonably representative (to an order-of-magnitude), the annual loading was estimated to be about 2 lbs/yr, and was entered as such in Table 3.9. It is noteworthy that limited mercury monitoring results at Iron Mountain Mine were all below detection.

Note c. Municipal and Industrial Wastewater

Municipal and industrial wastewater load estimates for mercury were obtained from estimates given in CVRWQCB, 1988, CVRWQCB, 1992, State of Estuary Report (SFEP, 1992), Sacramento River Mercury Control Planning Project (Sacramento Regional County Sanitation District, 1997) and discharge reports submitted by individual WWTPs in compliance with NPDES permits. The primary sources considered were municipal rather than industrial sources, except where compilations of industrial sources were already available. It should be noted that M & I mercury load estimates for mercury were hampered by the lack of data and/or the fact that most data are below detection levels.

Sacramento Region - The primary sources for mercury loadings in the Sacramento Basin were the values reported in the Sacramento River Mercury Control Planning Project (SRCSD, 1997). Table 1a of this report estimates an average annual mercury load from the Sacramento Regional Water Treatment Plant of 9.9 kg/yr. This value converts to about 22 lbs/yr which is the value used in Table 3.9.

Bay Region - Mercury loading estimates in the State of the Estuary Report (Table 19) are in the range of 0.4 metric tons/yr for major municipal and industrial sources (SFEP, 1992). When converted to lbs/yr (there are 2205 lbs/metric ton), this estimate is about 900 lbs/yr which was entered in Table 3.9.

Note d. Urban Runoff

Delta, Sacramento River Basin, San Joaquin River Basin - Most urban runoff data for mercury are below detection levels and urban runoff is not generally considered to be a significant source

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of mercury. Most available loading analyses conducted by stormwater NPDES programs do not report mercury loads.

Bay Region - Mercury load estimates for the Bay Region are provided in the State of the Estuary Report (Table 19) which gives a range of 0.026-0.15 metric tons/yr. The range reflects (in part) the uncertainty associated in interpreting data that contain a large number of non-detects. Our estimated value of 0.03 metric tons/yr assumes that non-detects may reflect zero or extremely minute levels of mercury. This value translates into a load of about 66 lbs/yr which was rounded to 70 lbs/yr in Table 3.9.

Note e. Basin Load Estimates

Sacramento Region - The primary sources of mercury loading for the Sacramento Basin were the values reported in the Sacramento River Mercury Control Planning Project (SRCSD, 1997). Table 1a of this report estimates an average annual mercury load to the Sacramento River at Freeport of 208 kg/yr. This value converts to about 460 lbs/yr, which is the value used in Table 3.9.

Nitrate Loading Notes

Note d. Urban Runoff

Lower Sacramento Basin - The principal source of urban runoff in the Lower Sacramento Basin is the Greater Sacramento Area. Runoff loading estimates for this area were developed and reported in the 1996 Discharge Characterization Program (DCP) Update Report (Sacramento NPDES Stormwater Program, 1996). Mean annual loading estimates for nitrate are given in Table 15 of this report as 812 tons/yr. Assuming these are short tons (2000 lbs/ton), this value translates into 1,624,000 lbs/yr. As this value does not include all urban runoff sources in the Lower Sacramento Basin, it was rounded up to 1,700,000 and entered in Table 3.10.

San Joaquin Basin - Important urban runoff sources in the San Joaquin Basin include the Fresno-Clovis Metropolitan Area, Modesto, and Manteca. Load estimates for the first two areas are available in load analyses conducted for the municipal NPDES stormwater programs. Loading estimates for the Fresno-Clovis Metropolitan Area are given in the program's report entitled "Estimate of Annual Pollutant Loads to Waters of the United States" (Fresno Metropolitan Flood Control District, 1995). Table 3 of that report gives a total nitrogen load of 65, 765 lbs/yr. Analysis of the ratio of nitrate as nitrogen to total nitrogen using data collected in Stockton (Stockton Municipal Stormwater Discharge Management Program, 1994) indicates that about 20% of the total nitrogen is in nitrate form. Applying this ratio to the Fresno total nitrogen load gives a nitrate as nitrogen load of 13,591 lbs/yr. Estimates developed for Modesto (Table 3-14 of a loading report developed by Archibald and Wallberg Consultants, received via FAX, 8 Apr., 1997) indicate that the total nitrogen load to all receiving waters is about 347,000 lbs/yr. Applying the same ratio of 20% for nitrate-nitrogen yields an estimate of 69,400 lbs/yr. Combining the estimates for Modesto and Fresno yields a total of about 83,000 lbs/yr. A rounded up value of 85,000 lbs/yr was used in Table 3-10.

Selenium Notes

Note a. Agricultural

Estimates of the contribution to selenium loads from agricultural sources were obtained from the following two data sources: Agricultural Drainage Contribution in the Grassland Area of Western Merced County, California: October 1994 to September 1995, December 1996 (CVRWQCB, 1996); and U.S. Bureau of Reclamation data provided by Joseph McGahan of Summers Engineering, Inc. (November, 1997).

San Joaquin Basin- Load estimates for the San Joaquin Basin are discussed below by information source.

CVRWQCB - Annual loads from Salt and Mud Sloughs for water years 1986-1995 are presented in Table 6 of the CVRWQCB report (1996). The average annual selenium load for all recorded water years is estimated to be 7,000 pounds. Note that Table 6 incorrectly states that the selenium load estimates are in tons rather than pounds.

U.S. Bureau of Reclamation- Data provided by Summers Engineering, Inc. includes annual selenium loads from Salt and Mud Sloughs estimated by the Bureau of Reclamation. The average annual selenium load from Salt and Mud Sloughs for water years 1986-1997 was also estimated to be 7,000 pounds.

Since the selenium load estimates from the two data sources match, 7,000 pounds was the value entered in Table 3.11 of this report.

Note c. Municipal and Industrial

Bay Region - Refinery discharges are important sources of selenium in the Bay Region. Regional Board staff estimated that the loads from the Shell, Exxon, Unocal/Tosco, Tosco, and Chevron refineries totaled about 11.6 lbs/day as of February, 1997 (San Francisco Bay Regional WQCB, Apr., 1997). If these loads would be sustained, the annual loads are about 4200 lbs/day. Estimates from wastewater plants are highly suspect because most measurement are below detection levels. The estimate for M&I loads as provided in Table 19 of the State of the Estuary Report (SFEP, 1992) is 2.1 metric tons or 4630 lbs, which agrees well with the refinery estimate. A rounded off value of 4500 lbs/day was used in Table 3.11.

Note e. Basin Estimates

San Joaquin Basin - Basin estimates for selenium used data reported by the USGS in cooperation with the San Joaquin Valley Drainage Program (USGS, 1988). Figure 67 of the USGS report shows an annual dissolved selenium load at Vernalis of about 4.6 tons, or about 9200 lbs/yr.

Total Dissolved Solids (TDS) Notes

Note a. Agricultural

Estimates of the contribution of TDS from agricultural sources were obtained using the following three data sources: Study of Drinking Water Quality in Delta Tributaries, April 1995 (CUWA, 1995); Agricultural Drainage Contribution in the Grassland Area of Western Merced County, California: October 1994 to September 1995, December 1996 (CVRWQCB, 1996); and U.S. Bureau of Reclamation data provided by Joseph McGahan of Summers Engineering, Inc. (November, 1997).

San Joaquin Basin- Load estimates for the San Joaquin Basin are discussed below by information source:

CUWA- Table D-7 of the CUWA report (CUWA, 1995) presents average daily loads from Mud and Salt Sloughs. The sloughs represent the two major agricultural drainages in the San Joaquin River and Basin. The loads were estimated using USGS flow and water quality data for water years 1986-1988. Water year 1986 represented a wet year, while water years 1987 and 1988 represented critically dry years. The mass load (pounds per day) was calculated as flow (cfs) * TDS concentration (mg/L) * 8.34 pounds/gallon * 0.64632 (conversion factor). Daily wet season and dry season loads were calculated for wet and critically dry water years. The study assumed 151 days in the wet season (December through January), and 214 days in the dry season.

Table D-7 (CUWA, 1995) includes wet and dry season loads for the one wet and two critically dry years between 1986-1988. The average wet season load was calculated using the wet season loads and the average dry season load was calculated using the dry season loads for the wet year and the two critically dry years of that period. The mean annual TDS load, which was the sum of average wet and dry season loads for all three years, was estimated to be 810,000,000 pounds per year.

CVRWQCB - Annual loads from Salt and Mud Sloughs for water years 1986-1995 are presented in Table 6 of the CVRWQCB report (1996). This source estimates the average annual TDS load for the 1986-1995 sequence of water years to be 730,000,000 pounds.

U.S. Bureau of Reclamation- Data provided by Summers Engineering, Inc. includes annual TDS loads from Salt and Mud Sloughs as estimated by the Bureau of Reclamation. They estimated the average annual TDS load from Salt and Mud Sloughs for water years 1986-1997 to be 830,000,000 pounds.

The three data sources of TDS loads provide comparable load estimates for the San Joaquin Basin. The value of 830,000,000 pounds was used to estimate the load and entered into Table 3.12 because it is derived from the largest data set covering the longest sequence of years.

Lower Sacramento Valley- Figure 4-3 of the CUWA (1995) report presents the TDS loads estimated from Sacramento Slough and Colusa Basin Drain. The loads were estimated using DWR's Northern District flow data for water years 1990-1993, and Municipal Water Quality Investigation Program (MWQIP) concentration data for water years 1990-1993. Water years 1990-1992 represented critically dry years, and water year 1993 was an above normal wet year. TDS data from the Natomas East Main Drain were used as a surrogate for Sacramento Slough and Colusa Basin Drain data because of the limited direct monitoring data available from the two major sources.

Figure 4-3 of the CUWA report shows the percent contribution from Sacramento Slough and Colusa Basin Drain to the total TDS load entering the Sacramento River above Greene's Landing. The average wet season load was calculated using the wet season loads for the wet year and the two critically dry years. The average dry season load was calculated using the dry season loads for the wet year and the three critically dry years. The annual TDS load, which was the sum of average wet and dry season loads, was estimated to be 1,200,000,000 pounds per year. However, the report indicated that Sacramento Slough and Colusa Basin Drain contribute about 80 percent of the rice field drainage to the Sacramento River. As such, the load was adjusted upward by 20 percent to account for the remaining agricultural sources of TDS. Therefore, the total annual TDS load, provided in Table 3.12 of this report, was estimated to be 1,600,000,000 pounds.

Note d. Urban Runoff

Lower Sacramento Basin - The largest metropolitan area in the Sacramento Basin is the Greater Sacramento Metropolitan Area. Stormwater loading estimates have been made for the area as part of the Sacramento NPDES Stormwater Discharge Characterization Program (1996). Table 15 of that report gives an annual value for TDS of 21,617 tons, which converts to 43 x 10^6 lbs/yr, the value entered in Table 3.12.

San Joaquin Basin - Metropolitan areas in the San Joaquin Basin that have reported stormwater results include the Fresno-Clovis Metropolitan Area (1995) and the City of Modesto Stormwater Program (Archibald and Wallberg Consultants , 1997). Table 3 of the Fresno report estimates that 295,778 lbs/yr of TDS are discharged to waters of the United States, which consist of the San Joaquin River, Dry Creek, and Herndon Canal. Similarly Table 3-14 of the Archibald and Wallberg report indicates that the estimated mean annual TDS load to the Tuolumne River, Dry Creek, and irrigation canals is 385,000 lbs/yr. The total of these two estimates is 680,778 which was rounded to 680,000 lbs/yr for entry into Table 3.12.

Note e. Basin Load Estimate

Lower Sacramento Basin - The total dissolved solids load estimate was obtained from Figure 4-3 in the 1995 CUWA Report which identified loads from a variety of sources contributing to loads at Greene's Landing. The estimates were made for two water year types: critically dry and wet years and for the wet versus dry seasons within each year type. Adding the two seasons together for each water year type, the mean annual wet year load was calculated to be about 34 x 10^6 lbs/day compared to dry year load of about 13.2 x 10^6 lbs/day. Based on historical water year types between 1906-1996, wet and above normal years seemed to occur for about the same number of year as below normal, dry, and critically dry years. Therefore the mean annual load was simply computed as the mean of the wet and dry year loads which equal 23.5 x 10^6 lbs/day, or about 8.6 x 10^9 lbs/yr, the value entered into Table 3.12.

San Joaquin Basin - The total dissolved solids load estimate was obtained from Figure 4-3 in the 1995 CUWA Report which identified loads from a variety of sources contributing to loads at Vernalis. The estimates were made for two water year types: critically dry and wet years and for the wet versus dry seasons within each year type. Adding the two seasons together for each water year type, the mean annual wet year load was calculated to be about 9.9 x 10^6 lbs/day compared to dry year load of about 6.3 x 10^6 lbs/day. Based on historical water year types between 1906-1996, wet and above normal years seemed to occur for about the same number of year as below normal, dry, and critically dry years. Therefore the mean annual load was simply computed as the mean of the wet and dry year loads which equals 8.1 x 10^6 lbs/day or about 2.9 x 10^9 lbs/yr, which is the value entered into Table 3.12.

Total Organic Carbon Notes

Note a. Agricultural

Estimates of the contribution of organic carbon from agricultural sources were obtained from the Study of Drinking Water Quality in Delta Tributaries, April 1995 (CUWA, 1995). Although the title of Table 3.13 of this report reads Total Organic Carbon (TOC), the load estimates were derived from dissolved organic carbon (DOC) since it is the only data available. The mass load (pounds per day) was calculated as flow (cfs) * DOC concentration (mg/L) * 8.34 pounds/gallon * 0.64632 (conversion factor). Wet season and dry season loads were calculated for wet and critically dry years. The study assumed 151 days in the wet season and 214 days in the dry season.

San Joaquin Basin- Table D-7 of the CUWA report (CUWA, 1995) presents average daily loads from Mud and Salt Sloughs. The sloughs represent the two major agricultural drainages in the San Joaquin River Basin. The loads were estimated using USGS flow and water quality data for water years 1986-1988. Water year 1986 represented a wet year, while water years 1987-1988 represented critically dry years.

Table D-7 includes wet and dry season loads for the wet and critically dry years stated above. The average wet season load was calculated using the wet season loads for the wet year and the two critically dry years. The average dry season load was calculated using the dry season loads for the wet year and the two critically dry years. The annual TOC load provided in Table 3.13 of this report is the sum of average wet and dry season loads, which was estimated to be 7,500,000 pounds per year (based on DOC monitoring).

Lower Sacramento Valley- Figure 4-1 of the CUWA (CUWA, 1995) report presents the DOC loads estimated from Sacramento Slough and Colusa Basin Drain. The loads were estimated using DWR's Northern District flow data for water years 1990-1993, and Municipal Water Quality Investigation Program (MWQIP) concentration data for water years 1990-1993. Water years 1990-1992 represented critically dry years, and water year 1993 was an above normal wet year. DOC data from the Natomas East Main Drain were used as a surrogate for Sacramento Slough and Colusa Basin Drain data because of the limited direct monitoring data. Other sources of TOC were ignored due to lack of data.

Figure 4-1 of the CUWA report shows the percent contribution from Sacramento Slough and Colusa Basin Drain to the total DOC load to the Sacramento River at Greene's Landing. The average wet season load was calculated using the wet season loads for the wet year and the three critically dry years. The average dry season load was calculated using the dry season loads for the wet year and the three critically dry years. The annual DOC load, which was the sum of average wet and dry season loads, was estimated to be 14,000,000 pounds per year. However, the report indicated that Sacramento Slough and Colusa Basin Drain contribute about 80 percent of the rice field drainage to the Sacramento River. Therefore, the load was adjusted upward by 20 percent to account for the remaining agricultural sources of DOC. The total annual DOC load provided in Table 3.13 of this report was estimated to be 17,000,000 pounds and the other components of TOC were ignored.

Note c. Municipal and Industrial Wastewater

Lower Sacramento Basin - The total organic carbon load estimate was obtained from Figure 4-1 in the 1995 CUWA Report which identified loads from a variety of tributaries to the Delta, and included load estimates from the Sacramento Regional Wastewater Treatment Plant. The total load of about 7.8 x 10^6 lbs/yr given in Table 3.13 is based on the sum of the average wet season and average dry season loads obtained from Figure 4-1 (CUWA, 1995).

Note e. Basin Load Estimate Notes

Lower Sacramento Basin - The total organic carbon load estimate was obtained from Figure 4-1 in the 1995 CUWA Report which identified loads from a variety of sources contributing to loads at Greene's landing. The estimates were made for two water year types: critically dry and wet years and for the wet versus dry seasons within each year type. Adding the two seasons together for each water year type, the mean annual wet year load was about 870,000 lbs/day compared to a mean annual dry year load of about 370,000 lbs/day. Based on historical water year types between 1906-1996, wet and above normal years seemed to occur for about the same number of year as below normal, dry, and critically dry years. Therefore the mean annual load was simply computed as the mean of the wet and dry year loads. This totaled 620,000 lbs/day or about 226 x 10^6 lbs/yr. This value was rounded off to 230 x 10^6 for entry into Table 3.13.

San Joaquin Basin - The total organic carbon load estimate was obtained from Figure 4-1 in the 1995 CUWA Report which identified loads from a variety of sources contributing to loads at Vernalis. The estimates were made for two water year types: critically dry and wet years and for the wet versus dry seasons within each year type. Adding the two seasons together for each water year type produced a mean annual wet year load of about 143,000 lbs/day compared to a dry year load of about 49,000 lbs/day. Based on historical water year types between 1906-1996, wet and above normal years seemed to occur for about the same number of years as below normal, dry, and critically dry years. Therefore the mean annual load was simply computed as the mean of the wet and dry year loads. This totaled 192,000 lbs/day or about 70 x 10^6 lbs/yr which was the value entered into Table 3.13.

Zinc Loading Notes

Note a. Agricultural

Estimates of the contribution of zinc from agricultural sources were obtained from A Mass Loading Assessment of Major Point and Non-Point Sources Discharging to Surface Waters in the Central Valley, California, 1985, by Montoya, Blatt, and Harris, (CVRWQCB, 1988), and the final version of the report published in March 1989 (CVRWQCB, 1989).

Lower Sacramento Valley- Table V-8 of the 1988 report (CVRWQCB, 1988) presents annual zinc loads from Sacramento Valley agricultural drains. Loads were calculated from the following five major agricultural drains: Sacramento Slough, Colusa Basin Drain, RD1000, RD108, and Toe Drain. The loads were estimated using 1985 flow volumes and 1985-1987 concentration data. Flow volumes were obtained from USGS and DWR data banks, Reclamation District records and DWR DAYFLOW reports. Concentration data were obtained from the Central Valley Regional Board and the SWRCB. Concentrations reported as non-detectables were assigned zero values for the load calculations. Loads were calculated separately for the rice season (May through June) and non-rice season because most pesticides are applied during the rice season.

The final 1989 report (CVRWQCB 1989) indicated that the 1988 load estimates were biased low due to the omission of some important agricultural sources. The adjusted annual zinc load from agricultural sources is provided in Table 1 of the 1989 report (CVRWQCB 1989), which is estimated to be 110,000 pounds. The value entered in Table 3.14 of this report was 110,000 pounds.

It should be noted that the adjusted loads accounted for sources above the dams in addition to those below the dams. However in Table 1, agricultural sources above the dams are considered to be minimal. Pesticide and herbicide application practices are known to have changed since the load estimates were performed in 1988; however more recent agricultural drainage water quality data for metals do not appear to be available.

Note b. Mining

Estimates of the contribution of zinc from mining sources were based primarily on data summarized from the following documents: A Mass Loading Assessment of Major Point and

Non-Point Sources Discharging to Surface Waters in the Central Valley, California, 1985, by Montoya, Blatt, and Harris, (CVRWQCB, 1988), the final version of this report published in 1989 (CVRWQCB, 1989), and Inactive Mine Drainage in the Sacramento Valley, California, by Montoya and Pan, (CVRWQCB, 1992).

Delta - Inactive mines located in and near the Delta include Penn Mine, Newton Mine, and Mt. Diablo Mine. According to Table IV-3 of CVRWQCB (1988), Penn Mine is a source of zinc, but no quantitative data are provided.

San Joaquin Basin - Inactive mines in the San Joaquin Basin include New Idria Mine. According to Table IV-3 (CVRWQCB, 1988), the New Idria Mine is not an important source of zinc.

Upper Sacramento Valley - Inactive mines in the Upper Sacramento Basin (above the major dams) include Little Backbone Creek, Shoemaker Gulch, West Squaw Creek, Rising Star, and Bully Hill. Based on the loading estimates for these mines contained in Table V-1 (CVRWQCB, 1992), the mean annual load from these mines in the drought period 1987-1991 was about 104,000 lbs/yr.

Lower Sacramento Valley - According to the CVRWQCB (1992), there are at least 16 major inactive mines in the Sacramento Valley below the major dams, the most prominent of which is Iron Mountain. Table V-1 of this reference provides loading estimates for these mines for the drought period from 1987-1991. Based on this table the mean annual load for zinc from these 16 mines was about 470,000 lbs/yr. In 1985, the annual zinc load from Iron Mountain Mine (which may account for more than 95% of the total load for all mines) was estimated to be about 1,150,000 lbs/yr (CVRWQCB, 1988, Table IV-9).

Sacramento Valley - By extrapolating measured data to other locations, the CVRWQCB estimated the total zinc load from all mines in the Sacramento Valley to be about 5, 450,000 lbs/yr (CVRWQCB, 1989, Table 1). This was apportioned between the upper and lower portions of the Valley using the 1987-1991 load estimates. This produced an estimate of 104/(104+470) = 18%, which is about 990,000 lbs/yr for the Upper Sacramento Valley. The remaining 4,460,000 lbs/yr was attributed to the Lower Sacramento Valley.

Note c. Municipal and Industrial Wastewater

Municipal and industrial wastewater load estimates for zinc were obtained from estimates given in CVRWQCB (1988), CVRWQCB, 1992, the State of Estuary Report (SFEP, 1992), and discharge reports submitted by individual WWTPs in compliance with NPDES permits. The primary sources considered were municipal rather than industrial sources, except where compilations of industrial sources were already available.

Delta Region - The larger WWTPs in the Delta are those operated by the cities of Stockton, Manteca and Tracy, with Stockton being by far the largest discharge. Mean monthly flows for the year 1985 at Stockton were about 25 MGD, compared to about 5 MGD for Tracy (CVRWQCB, 1988). The 1985 zinc loads from Stockton were estimated at 1728 lbs/yr and a rounded estimate of 2000 lbs/yr was used in Table 3.14.

Lower Sacramento Basin - WWTPs in the lower Sacramento Valley include Sacramento Regional and Redding. Estimates for Sacramento WWTP and other NPDES dischargers, for 1985, totaled about 34,000 lbs/yr (CVRWQCB, 1989) and this value was used in Table 3.14.

San Joaquin Valley - WWTPs in the San Joaquin Valley include the cities of Fresno and Modesto. The City of Modesto provided monitoring data for NPDES requirements, but these did not include metals data. The entry for Table 3.14 was therefore given as "further literature review required".

Bay Region - Zinc loading estimates in Table 19 of the State of the Estuary Report are in the range of 80 metric tons/yr for major municipal and industrial sources (SFEP, 1992). This value, when converted to lbs/yr (there are 2205 lbs/metric ton), is about 175,000 lbs/yr which was entered in Table 3.14.

Upper Sacramento Basin - M & I sources of zinc are minimal in the Upper Sacramento and are considered insignificant.

Note d. Urban Runoff

Delta - Urban runoff estimates were obtained from A Mass Loading Assessment Report published by the Central Valley RWQCB (CVRWQCB, 1988), in Tables VI-4 and VI-5. Load estimates were made for the following seven cities in and near the Delta: Stockton, Vacaville, Lodi, Woodland, Manteca, Tracy, and Davis, based on annual rainfall, urban acreage, and an assumed runoff factor of 0.3. Water quality data for all areas was assumed to be the same as the City of Sacramento. Total annual metals loads for the Central Valley given in Table VI-4 were apportioned to the Delta, Sacramento Valley, and San Joaquin Valley using total urbanized area as given in Table VI-5 (CVRWQCB, 1988). Given that these estimates did not include all urbanized areas and do not include increased urbanization since 1985, a correction factor of 1.3 was arbitrarily assigned to the loads. This approach produces a total zinc load of: 194,000 lbs (from Table VI-4) x 0.15 (from Table VI-5) x 1.3 = 37,830 lbs, which was rounded off to 38,000 lbs/yr of zinc in Table 3.14.

Lower Sacramento - Load estimates for the Lower Sacramento were reported in a load assessment conducted by the Central Valley Regional Board (CVRWQCB, 1988) for the following cities: Sacramento, Redding, Chico, Roseville, Paradise, and Yuba City. Using the same method as described for the Delta, the mean annual zinc load is calculated as 194,000 lbs (from Table VI-4) x 0.64 (from Table VI-5) x 1.3 = 161,400 lbs, which was rounded off to 161,000 lbs for entry in Table 3.14.

San Joaquin - Load estimates for the San Joaquin Basin were reported in a load assessment conducted by the Central Valley Regional Board (CVRWQCB, 1988) based on information for the following cities: Madera, Modesto, Merced, Turlock, Ceres, and Atwater. Using the same method as described for the Delta, the mean annual zinc load is: 194,000 lbs (from Table VI-4) x

0.21 (from Table VI-5) x 1.3 = 52,962 lbs, which was rounded off to 53,000 lbs in Table 3.15.

Bay Region - Zinc load estimates for the Bay Region were obtained from Table 19 of the State of the Estuary Report which gives a range of 34-268 metric tons/yr. Using an intermediate value of about 100 metric tons/yr, this converts to about 220,500 lbs/yr. A rounded value of 220,000 lbs/yr was entered in Table 3.15.

Note e. Basin Estimates

San Joaquin Basin - For estimating basin emission loads, flow data were retrieved from the USGS Water Resources of California internet site http://water.wr.usgs.gov/ for the San Joaquin River near Vernalis (station #11303500), and constituent concentration data were obtained for the period 1985-1990 from EarthInfo/USGS, Quality of Water database on CD-ROM (EarthInfo, 1996). During this period, a total of 89 zinc samples were taken.

In order to take into account possible seasonal changes in water quality, the load analysis was done by month. For example, all of the water quality samples for January from 1985 to 1990 were grouped together for the January mean load estimation. Any constituent concentration value that was below the detection limit was assumed to be half of the detection limit.
For each month of the year, days in which both water quality and flow were measured were identified and individual daily loads were calculated as the product of flow times concentration. Monthly mean loads were estimated as the average of the daily loads for each month times the number of days in the month.

In order to account for the possibility that flows during the 5 year water quality record were not representative, monthly loads were corrected for flow by dividing by the following correction factor.

Fraction of Mean Monthly Flow = average flow for each month / long-term monthly mean flow.

Note that the application of such a factor assumes that flow and water quality are uncorrelated, which is generally the case for the constituents considered (it is not the case for constituents such as TDS, TSS, and bromide).

After taking into account the correction factors, the final monthly mean load equation is:

Monthly Mean Load = Average Daily Loads for the Month * Number of Days in the Month / Fraction of Mean Monthly Flow.

The annual basin emission was the sum of the twelve monthly mean loads.

Using this methodology, the annual zinc load from the basin was estimated to be 250,000 lbs/yr, and this value was entered in Table 3.14. For comparison, the annual load from the San Joaquin River into San Francisco Bay is estimated to be 170 metric tons/yr (Table 19, SFEP, 1992) or about 375,000 lbs/yr.

Lower Sacramento Basin - For estimating basin emission loads, flow data were retrieved from the USGS Water Resources of California internet site http://water.wr.usgs.gov/ for the Sacramento River at Greene's Landing, and constituent concentration data were obtained for the period 1986-1990 from the EarthInfo/USGS Quality of Water database on CD-ROM (EarthInfo, 1996). During this period, a total of 57 zinc samples were taken.

In order to take into account possible seasonal changes in water quality, the load analysis was done by month. For example, all of the water quality samples for January from 1986 to 1990 were grouped together for the January mean load estimation. Any constituent concentration value that was below the detection limit was assumed to be half of the detection limit.
For each month of the year, days in which both water quality and flow were measured were identified and individual daily loads were calculated as the product of flow times concentration. Monthly mean loads were estimated based on the average of the daily loads for each month times the number of days in the month.

In order to account for the possibility that flows during the 5 year water quality record were not representative, monthly loads were corrected for flow by dividing by the following correction factor:

Fraction of Mean Monthly Flow = average flow for each month / long-term monthly mean flow.

Note that the application of such a factor assumes that flow and water quality are not correlated, which is generally the case for the constituents considered (it is not the case for constituents such as TDS, TSS, and bromide).

After taking into account the correction factors, the final monthly mean load equation is:

Monthly Mean Load = Average Daily Loads for the Month * Days of the Month / Fraction of Mean Monthly Flow.

The annual basin emission was the sum of the twelve monthly mean loads.

Using this methodology, the annual zinc load from the basin was estimated to be 1,300,000 lbs/yr and this value was entered in Table 3.14.

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